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The Role of Energy in the Productivity Slowdown: A Comment

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THE ROLE OF ENERGY IN THE PRODUCTIVITY SLOWDOWN: A COMMENT

Jorgenson (1982) offers a detailed sectoral account of the slowdown in productivity growth in the U.S. economy. His approach is appealing for its microeconomic foundations and its detail; it is all the more impressive for deriving the significant empirical findings that higher energy prices account for the sharp slowdown in the productivity growth after 1973. No doubt I am impressed because the results agree so closely with my own results and those with Robert H. Rasche for the productivity slowdown in the U.S. and elsewhere, but the "single bullet" and "smoking gun" features of the results cannot escape even cynics.

There may be major differences between my explanation of this result and Jorgenson's that could be explored, but I neither wish to, nor am I able to do that here. Instead, I wish to note my agreement with Jorgenson's conclusion, but express strong disagreement with his claim that a sectoral approach is a <u>sine qua non</u> for elaborating and testing the energy hypothesis, and, more important, my surprise and dissent at his assertions about the dismal implications for productivity growth in this decade. Before turning to these comments, there are two important points about the energy price hypothesis as an explanation for the international productivity slowdown since 1973 that require clarification.

1. <u>The Evidence From OPEC 1 and OPEC 2</u>

It is conventional and generally useful in productivity growth accounting to discuss <u>trends</u> in factor input growth, and productivity growth. Most of the papers at this conference follow this procedure. For example, factors influencing the average rate of growth of productivity over the periods 1960-73 and 1973-81, are compared by Maddison (1982) to account for differences in productivity growth between the two periods.[1/]

In the case of both the international productivity slowdown and the energy price hypothesis this procedure is misleading, at best, and obscures some important information about the slowdown. In particular, the major energy price increases took place in two distinct shocks. From IV/1973 to III/1974 and from IV/1978 to I/1980, the relative price of energy in the U.S. rose 40 percent ($\Delta \ln$). During the intervening period, the relative price rose very little (about 10 percent or 2 percent per year). Rasche and Tatom (1977a, b, and 1981) and Tatom (1979a, b) explain that these shocks render some domestic capital and labor obsolete, i.e., productivity of existing resources falls; in addition, the obsolesence in the capital stock is not accompanied by a decline in the real rental price of capital so that, over time, the capital stock is reduced to a lower desired capital-labor ratio. As a result, the productivity response to an energy shock is an immediate once-and-for-all decline, followed by temporarily slower productivity growth until the capital stock adjustment is complete.

The two shocks in 1973-80 provide important evidence on this adjustment pattern. Table 1 shows the growth rate of real GDP per employed person in nine countries for the periods 1960-73, 1973-75, 1975-78, 1978-81 and 1973-81. Following each of the two shocks productivity growth dropped off sharply in all countries. In 1975-78 productivity growth was lower than in 1960-73, but nonetheless was reaccelerating back toward the pre-1973 trend. Spreading these changes over the past eight years distorts the pattern by smoothing it. It obscures both the return of productivity growth to its pre-1973 trend following the first sharp decline, as well as the tight link between the productivity breaks and the energy price shocks.

Tatom (1982, p. 11) shows that potential productivity growth was 1.88 percentage points slower from the end of 1973 to the end of 1980. Since the end of 1980 there have been no adverse changes in U.S. productivity due to energy price changes; these prices were virtually the same in III/1982 as at the end of 1980. Of the 1973-80 reduction, 1.20 percentage points was directly due to energy price increases, and 0.64 percentage points arose from a reduction in the growth of the high-employment ratio of capital stock to hours of all persons. Most of this slowing in capital-formation was due to the effect of higher energy prices on the desired capital-labor ratio. The growth of the high-employment capital-labor ratio slowed from a 3.52 percent rate to 1.04 percent from the period

IV/1948-IV/1973 to the period IV/1973-IV/1980. When Jorgenson's data set and analysis are extended beyond 1976, they are likely to provide additional evidence on this pattern. The lion's share of the productivity slowdown was concentrated in 1974-75 and 1979-80 due to the immediate or "direct" energy price effects.

The second point that is misleading when one examines the international productivity slowdown is that one might infer that smaller declines in productivity are always to be preferred to larger ones; <u>other things equal</u>, they are. Casual observation, however, can erroneously suggest that countries in which productivity has declined less in the past decade have fared better than others. Under the energy price hypothesis, all countries experience a negative shock to productivity proportional in size to the energy intensity of domestic production. Observation accords with this hypothesis [see Tatom (1979c), Rasche and Tatom (1981), and Table 1] but the observations of output per worker can be misleading. In particular, observed output per hour or per person employed measures need not decline after a negative shock to the productivity of, and demand for, labor (and capital). If real wages are relatively rigid, for example when protected by extensive indexation, little decline in productivity will be observed. In such an instance, however, the decline in living standards tends to be amplified, as not only will less energy and capital be used in production, less labor will be used as well.

Figure 1 reveals the point, usually made for capital, that applies to labor when real wages are rigid in a downward direction. Suppose initially full-employment obtains at real wage W_0, and then there is a negative productivity shock that would otherwise lead to real wage W_1. If real wages cannot decline, employment will fall to E'; the natural rate of unemployment rises compounding the output loss due to the productivity shock. Note, however, that the marginal productivity (and under usually justifiable assumptions, the average productivity of labor) does not decline at real wage W_0. The decline in productivity at the initial level of employment will be observed as a decline in employment rather than in labor productivity.

Table 2 provides evidence of the substitution of employment reductions for productivity declines. Reductions in the rate of growth of GDP per person employed and in employment growth are shown for nine countries. Excluding Japan the correlation between these reductions is very high, -0.89, and a regression of the productivity reduction on the employment reduction for these eight countries yields a slope coefficient of -1.004, suggesting that the reduction in the GDP trend is similar across these eight countries. In Japan, reductions in both productivity and employment growth are much larger, so that the reduction in the growth of GDP between the two periods was about twice as large as that for the other eight countries. More to the point, however, are the relatively smaller reductions in productivity growth in Germany, Belgium and the U.K., which appear to have come at the expense of the three largest reductions in employment growth. Belgium stands out as the country where this trade-off was most severe, as both the reduction in GDP growth and the reduction in employment growth were among the largest of the nine countries. In the U.K. and Germany, the GDP growth reductions were lower than in all other countries except the U.S. Italy appears to be a contrasting example at the other extreme of this substitution where the reduction in productivity growth was largest but an acceleration in employment growth occurred.

This analysis should be considered cautiously. While it illustrates the trade-off between productivity growth reductions and employment reductions in the event of a productivity shock, there are many other factors that influence these developments including differences in the size of the initial shock and in demand management policies in the past decade. More precise estimates of the size of the energy shock, given labor and capital employment, can be found in Rasche and Tatom (1981).

2. The Sectoral Approach vs. Aggregate Productivity Analysis

Jorgenson asserts that sectoral analysis of gross output production functions is necessary to examine the energy price hypothesis. Indeed, he states that "In aggregative studies of the sources of economic growth energy does not appear as an input, since energy is an intermediate good and flows of intermediate goods appear as both outputs and inputs of individual industrial sectors, canceling out for the economy as a whole," agreeing with Denison (1979). Such a claim appears to be more appropriately made for the use of gross output production functions instead of value-added, whether at an aggregate level or sectoral level. Even this qualification is erroneous, however. While sectoral and gross output analyses are capable of enriching the detail of the hypothesis and providing more instances for testing it, such analyses are not *sine qua non*. It is relatively easy to derive appropriate value-added productivity relationships that exhibit energy price effects, for firms or the whole economy. Moreover, Tatom (1981) has shown that the energy price hypothesis can be successfully tested within a small reduced-form macroeconomic model without reference to the particular structural parameters of a gross or net output production function, or the parameters of the aggregate supply function.

Consideration of gross output (Y) as a function of labor (L) capital (K) and materials (M), including both energy and non-energy materials, simply adds a layer of analysis required to derive the value-added relationship. Value-added (V) is simply gross output less the portion of gross output accounted for by materials, $V = Y - p_M M$, where p_M is the price of materials relative to that of gross output. The "canceling out" confusion arises because optimal employment of materials requires equating the marginal gross product ($\partial Y/\partial M$) to this relative price of materials so that $\partial V/\partial M = 0$, that is, the addition to gross output simply is offset by the increased real total cost of M. This is an important marginal result, but not the relevant experiment for considering whether a change in the relative price of materials will affect value-added.

The relevant experiment can be seen most easily by consideration of a simple gross output production function in the four factors K, L, E, and M, $Y = AL^a K^b E^g M^d$, where E is energy and M is non-energy materials. The latter are assumed to be of an ingredient type such that the demand for materials is a fixed proportion z of gross output. The Cobb-Douglas assumption simplifies the arithmetic without loss of generality. A translog specification would only involve the inclusion of higher powers of the capital-labor ratio in the value-added function below [see Tatom (1979a)]. The non-energy materials can be omitted from the production function explicitly by substitution of $M = zY$, resulting in $Y =$

$A'L^{\alpha}K^{\beta}E^{\gamma}$ where $A' = z^{d}A$ and $\alpha = a/1\text{-}d$, $\beta =$ $b/1\text{-}d$, and $\gamma = g/1\text{-}d$. Again, value-added is simply $Y - p_E E - p_M M$. The latter two expressions are found from first order conditions to be gY and dY, respectively so that $V = (1\text{-}g\text{-}d)\ Y$, i.e., value added is a fraction of gross output that depends only on the shares of energy and non-energy materials in the cost of gross output. The value added production function can be written as $V = (1\text{-}g\text{-}d)[A''L^{\alpha}K^{\beta}p_e^{-\gamma}]^{1/1-\gamma}$. Such an expression has been used for estimating the productivity effect of a rise in the relative price of energy, for example by Rasche and Tatom (1977b).

In this example, it is apparent that a rise in the relative price of materials affects value-added, given (L, K) and that the corresponding declines in the relative prices of (L, K) can have secondary and, in the case of K, long-run consequences, by reducing (L or K). "Canceling out" remains the case, i.e., $p_M = \partial Y/\partial M$ and $p_E = \partial Y/\partial E$, but energy prices nonetheless affect value-added and the value-added marginal productivity of labor and capital. Finally, it is interesting to note that Jorgenson claims a share of energy in gross output of 5 percent, which is consistent with a γ estimate of about 8.7 percent observed in Tatom (1982) for annual data from 1949-80 or 8.9 percent in a recent quarterly estimate for the period I/1948 to II/1982, if the share of non-energy materials in gross output is about 57 percent, which it is. Denison's earlier claims (1979, p. 16-18) that an energy share in gross output of 5 percent is too small to account for the productivity decline and that our higher estimate of this effect is too large are not accurate.

3. The Jorgensonian Outlook

Following his empirical investigation of the 1973-76 slowdown, Jorgenson takes up his last objective, that of providing a prognosis for future growth. His prognosis is that economic performance in the 1980s could be worse than that since 1973. This conclusion purportedly follows from sharp increases in energy prices since 1978 and recent fiscal policy changes that will presumably deter growth in the capital stock. Among the major adverse energy price changes are the 1979-80 world petroleum price increases, the January 1981 decontrol of the U.S. crude oil market, and decontrol of natural gas under the Natural Gas Policy Act of 1978. Jorgenson's conclusion is almost totally unfounded. All but one of the developments cited by Jorgenson will lead to an acceleration in productivity growth in the 1980s.

The 1979-80 energy price increases consequent to sharp OPEC price increases did reduce productivity and its growth rate. Indeed, the rise in the price of fuel, related products and power relative to the implicit price deflator for private business sector output matched that in 1973-74 with a resulting equal and immediate loss in productivity, a slowing in the growth of the capital-labor ratio, and temporarily slower productivity growth. These adjustments are largely completed, however. Also, unlike 1973-74, the 1979 world price increase was due to military and political factors that are more likely to be self-liquidating, creating the possibility of a major reversal of that price surge.

Decontrol of crude oil in 1981 substantially lowered oil and energy prices. Decontrol of the U.S. crude oil market increased the responsiveness of both U.S. oil supplies and demand to world oil prices. As a result, the world demand for OPEC oil was reduced and, more important, the elasticity of demand for OPEC oil was increased. These changes lowered the optimal price of world oil substantially. The world price of crude oil was about $39 per barrel in February 1981 and has plummeted since then due to decontrol. The average price of oil to U.S. refiners is currently (II/1982) about 20 percent below the pre-decontrol level of imported oil in nominal terms.

Some analysts have argued that this decline in oil prices is due to the world recession. Such a suggestion ignores the fact that, prior to decontrol, the world price continued to surge upward throughout 1980 and early 1981, while the U.S. and the world economy plummeted into recession, and that the decline proceeded most rapidly while real growth strengthened in most countries during 1981. Only since then have oil price declines occurred simultaneously with recession. That recent oil price declines are associated with recession requires a belief in heretofore nonexistent long and discontinuous lags and a belief in cyclical energy prices that belies the post-World War II experience in the U.S., or 1974-80 behavior of oil or energy prices under OPEC domination.

Natural gas decontrol will also lower world energy prices. Such decontrol increases the effective elasticity of the supply of U.S. natural gas, as well as its supply. In addition, such decontrol will reduce the substantial exchange inefficiencies in U.S. energy markets that were not associated with the entitlement system for crude oil. Ott and Tatom (1982) provide evidence that decontrol from late 1981 prices would eliminate the price gap between oil and gas primarily by depressing world oil prices, again due to a decline in demand and rise in the elasticity of demand for OPEC oil. This, in turn, will raise productivity, lower the general level of prices, and improve productivity and capital formation. For example, the gain in potential output and productivity is estimated to be 1.5 to 3 percent.

Jorgenson's fiscal policy argument is also bewildering. He emphasizes that the 1981 tax cut was not matched by expenditure reductions. Resulting deficits, he claims, have raised the real rate of interest, nullifying the tax cut effect, and resulted in a plummeting of capital spending. In addition, he cites the inefficiencies in capital allocation introduced by widening gaps in effective tax rates due to the 1981-82 tax acts, gaps that are inversely related to inflation.

The central issue, however, is the direction of the effect of the two tax acts on capital formation. It is far from clear that overall inefficiencies have risen. More important, so long as more capital, with a positive rate of return, is available, output per worker is improved. The casual evidence provides no support for Jorgenson's view that capital spending has plummeted. Nonresidential fixed investment as a share of GNP has moved in a tight band around an average of 11.5 percent during the past four quarters despite record nominal interest rates and reductions in capacity utilization to record lows. Such a ratio is well above that normally associated with investment booms. If GNP is adjusted upward to reflect an estimated 11 percent GNP gap, such levels of the investment ratio are even more impressive.

Cyclical considerations also apply to Jorgenson's claim that federal expenditures as a share of GNP have remained constant. Such a constancy would reflect the fact that federal expenditure growth declined in line with the sharp slowing in GNP growth. Adjusted for spending increases associated with the recession and for the GNP gap, high-employment expenditure growth has slowed sharply over the past 6 quarters.

There is no evidence provided to indicate that large deficits have raised the real rate. Such a result, if arising from a "tax cut" has little basis in theory or in past evidence. More likely, high real rates reflect (1) a reduction in inflationary expectations, (2) the increase in capital demand occasioned by the 1981 tax act, (3) the broadening of the tax-exempt market (IRAs and All Savers Certificates), and (4) the transformation of a promised immediate real personal income tax rate cut into a temporarily continuing rise in marginal tax rates, and legislated lower future marginal tax rates on real income. Both higher tax rates in the present and lower tax rates in the future provide disincentives to current saving.

Capital spending may slow as a result of the recession and low level of utilization. Nonetheless, it would slow from an unusually strong level when cyclical considerations are taken into account. Both the business tax cut and recent energy policy changes appear to be having their intended effects on high-employment productivity growth.

FOOTNOTES

[1]This procedure yields an upward bias in the extent of the slowdown since the 1960-73 period involves the calculation of productivity growth from a cyclical trough to a peak, while the 1973-81 calculation runs from a peak to a trough. This problem applies to the calculation for other countries as well where cyclical conditions were similar and productivity is also cyclical.

TABLE 1

Growth Rates of GDP Per Employed Person

	1960-73	1973-75	1975-78	1978-81	1973-81
United States	2.2	-1.2	1.4	0.0	0.2
Canada	2.6	-0.6	1.6	-1.0	6.0
Japan	8.4	1.0	4.0	3.7	3.1
Belgium	4.2	1.3	3.5	1.5	2.2
France	4.9	1.8	3.4	2.1	2.5
Germany	4.3	2.0	3.9	1.6	2.6
Italy	5.9	-1.0	2.9	1.9	1.5
Netherlands	4.1	1.5	3.2	-0.3	1.5
United Kingdom	2.9	-0.7	2.7	1.3	1.3

SOURCE: Unpublished data provided by the Bureau of Labor Statistics, U.S. Department of Labor.

TABLE 2

Reduction in GDP Growth
(1960-73 to 1973-81)

	Decline in Productivity Growth	Decline in Employment Growth
United States	2.0 %	-0.1 %
Canada	2.6	0.2
Japan	5.3	0.9
Belgium	2.0	1.0
France	2.4	0.5
Germany	1.7	0.7
Italy	4.5	-1.5
Netherlands	2.6	0.6
United Kingdom	1.6	1.0

SOURCE: Unpublished data provided by the Bureau of Labor Statistics, U.S. Department of Labor.

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Figure 1

A Productivity Shock with Fixed Real Wages